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Description

The invention relates to a point-to-multipoint television transmission system including at least one low power transmitter station and a plurality of receiver stations, the transmitter station comprising a substantially omnidirectional transmitting antenna and each receiver station comprising a directional receiving antenna being directed to receive a television signal from said omnidirectional transmitting antenna.

Such a system is described in the article "Low-power television" by George Jacobs in IEEE spectrum 1982, pp. 54-59.

This article describes a television broadcasting system including one low power transmitter station that transmits its particular programme over a limited region. The article also describes the situation in which a plurality of low power transmitter stations, each broadcasting a different programme, is dispersed over a certain region. The programs are broadcast in the VHF or UHF band.

The present invention has for its object to provide an efficient point-to-multipoint low-power television transmission system with which it is possible to broadcast the same programme to a number of receiving stations that are dispersed over a large area.

To this effect a system of the abovementioned type is characterised by the features of the characterising clause of claim 1.

DE-B-2,659,638 discloses a telecommunications system with a central transmitter and subscriber stations within a geographical range, the range being divided into sectors. Spatial decoupling between adjoining range sectors is achieved by using directional antennas. It is a radio rather than television system and uses frequencies well below the millimetre waveband frequencies. The possibility is suggested of making adjacent antennae of different polarisations. The feature of claim 2 is concerned with differences of polarisation of signals from adjacent transmitters, and not between directional antennas at a single station.

With the system according to the invention it is possible to broadcast television signals to all receiving stations in a cell in an efficient way and with low distortion.

An example of the invention will now be described with reference to the accompanying drawings in which:

Figure 1A is a schematic diagram of a receiver according to the preferred embodiment of the invention.

Figure 1B is a schematic diagram of an alternative frequency plan.

Figure 1C is a schematic of a receiver having repeater rebroadcast capabilities.

Figure 2 is a schematic diagram of the transmitter according to the preferred embodiment of the invention.

Figure 3 is a top plane view illustrating the overall organization of the antenna array with respect to individual transmitter and receiver stations.

Figure 4A illustrates the spacial diversity of transmitter and subscriber receiver antennas within a given cell of the system.

Figure 4B illustrates the relationship between two or more subscriber receiving stations and their common omnidirectional antennas within a given cell of the system.

Figure 5A illustrates an extended cell employing a repeater station to extend the range of the system.

Figure 5B is a plan view of an extended cell such as illustrated in Figure 5A.

Figure 6 is a graph of the characteristic of the improved transmitter phase filter.

During the course of this description like numbers will be used to identify like elements according to the different figures which illustrate the invention.

It is easiest to understand the invention by first focusing on the smallest common element, namely the receiver 10 illustrated in Figure 1A and then working up through the transmitter system 60 illustrated in Figure 2 to the overall system 200 illustrated in Figure 3. Each receiver 10 according to the preferred embodiment of the invention includes an antenna 12 having elements 14 and 16 for receiving vertically polarized signals Tx 64 and transmitting horizontally polarized signals Tr 68 respectively. Accordingly, antenna 12 is used for polarization diverse transmission and reception that may be implemented either by two separate antennas having two different polarizations or by a single antenna 12 combining the two polarization capabilities as illustrated in Figure 1A. Local oscillator 26 generates a signal that is mixed with the incoming 27.5 to 29.5 GHz modulated carrier in a first frequency converter FC#1 18 to produce in the case of television reception a 200 to 2200 MHz frequency modulated band containing a number of video signals with audio subcarriers. The output signal is amplified by amplifier 20 and directly coupled through coupler 22 to a second frequency converter FC#2 28. A portion of the signal from the first frequency converter FC#1 18 is fed back to local oscillator 26 through discriminator 24. The voltage fed back to local oscillator 26 controls its frequency so as to lock it to the master oscillator frequency L_1 at the omni-directional transmitter station 60 illustrated in Figure 2. Accordingly, discriminator 24 and local variable oscillator 26 form part of a phase locked loop. Thus, even if a given omni-directional transmitter 60 drifts as a function of temperature or time, all receivers 10 will track it without the need for expensive crystal controlled master oscillators or local oscillators within the receivers 10 themselves.

Signals from the second frequency converter FC#2 28 are fed through amplifier 30 and filter 32 to discriminator 34. A portion of the signal from discriminator 34 is fed back to manually tunable local oscillator 38 whose output is also fed back as a second input to the second frequency converter FC#2 28. Oscillator 38 is manually tunable by control 48. The described apparatus is especially efficient and low cost in that only one specific signal is selected through the use of manually tuned oscillator 38 and the automatic frequency control (AFC) loop in which it is found. Amplifier 36 amplifies the signal from discriminator 34 and produces an amplified output at terminal 50. Nearly all interfering oscillators from other cells will vary at different frequency rates in a random fashion thereby being further attenuated by the strong signal capture characteristics of oscillator 26 dictated by the prime amplitude modulated signal in the principle cell. The result is an amplitude modulated signal at discriminator 34 which coincides with the standard VHF television channels 3 or 4 on a video monitor receiver. Accordingly, the signal at output terminal 50 can be fed directly to a standard television receiver.

| | <u>Element Number</u> | <u>Element Name</u> | <u>General Description</u> | <u>Vendor</u> |
|----|-----------------------|---------------------|--|--|
| 15 | 12 | Antenna | Dual polarization 1 to 2 Ft dia. horn 2" to 6" Stripline (duroid) array [gain and directivity on area] Frequency 27.5 to 29.5 GHz | MA/COM Seavey (Feed) Ball Brothers |
| 20 | 100 | Directional coupler | 10 dB directional coupler WR 28 waveguide | Krytan MDC |
| 25 | 13 | Variable attenuator | 0 to 20 dB attenuation WR 28 waveguide | Narda |

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|----|---------------------|--|---|
| 18 | Frequency Converter | Conversion loss, LC = 10 dB max FLO = 27.3 GHz Local oscillator, drive > + 10 dBm < + 15 dBm VSWR 2:1, noise figure 12 dB, max Dynamic Range (1 MHz bandwidth) = 110 dB | TRW Microwave RHG MC/COM |
| 5 | | | |
| 10 | 20 | Amplifier | Gain 20 to 40 dB frequency 200 to 2200 MHz 1 dB compression (output) + 15 dBm |
| 15 | 22 | Coupler | 10 dB to 20 dB, frequency 200 to 2200 MHz |
| 20 | 24, 26 | AFC Oscillator | Frequency 27.300 GHz Power output + 15 dBm lock range 30 MHz |
| 25 | 28 | Frequency Converter | Frequency 200 to 2200 MHz double balanced image rejection, dynamic range (1 MHz bandwidth) = 110 dBm Local oscillator 130 to 2130 MHz, Noise figure 15 dB max |
| 30 | 30 | Amplifier | Frequency 200 MHz, AGC, Gain 20 to 40 dB |
| 35 | 34, 38 | Oscillator | Mechanically tuned plo frequency 130 & is to 2130 MHz (could be in 2-4 bands) power output + 15 dBm |
| 40 | 36 | | 20 dB video amplifier frequency 0 to 6.5 MHz |
| 45 | 11 | Antenna | Same as 12 except single polarization |
| 50 | 313 | Variable Attenuator | WR-28, WG, 0 to 20 dB |
| 55 | 318 | FC # 1 | Conversion loss 10 dB max noise figure 12 dB |
| | 320 | Amplifier | G = 20 dB, N.F. = 2.5 dB freq. 940-1440 MHz or freq. 440-940 MHz |
| | 321 | Receiver | Freq. = 940-1440 MHz or = 440-940 MHz |
| | | | Scientific Atlanta Tx Engr. General Instrument Adams Russell |

An alternate frequency plan scheme utilizing the same basic concept is to divide the incoming 27.5 to 29.5 GHz signal band into four equal 500 MHZ segments as shown in Figure 1B. This alternative system can employ fixed cavity stabilized oscillators or the frequency control system outlined previously.

| | <u>Element Number</u> | <u>Element Name</u> | <u>General Description</u> |
|----|-----------------------|----------------------|--|
| 5 | 313 | Variable attenuation | Automatic level adjustment |
| 10 | 318 | Frequency Converter | Balanced or double balanced in order to achieve 60 dB image rejection conversion loss 7 dB max single sideband noise figure 10 dB max (with IF N.F. = 2.5 dB) VSWR 1.5:1 L.O. level + 10 dBm per pair diodes |
| 15 | 320 | Amplifier | Gain = 16 dB min Noise figure 2.5 dB max 1 dB gain compression = 10 dBm, input/output VSWR 1.5:1, reverse isolation 30 dB |
| 20 | Local Oscillator | | Power output + 16 dBm or + 10 dBm (balanced or double balanced), frequency tunable 26.55 - 28.05 GHz with AFC to L1 (or cavity stabilized fixed frequency) |
| 25 | | | |
| 30 | | | |

35 A two-way transmission format is made possible by employing the horizontal polarization transmission portion 16 of the antenna 12. The local system oscillator 26, which is frequency synchronized to one amplitude modulated carrier among the multiple frequency modulated carriers of the omni-directional transmitter 60, is used to drive offset mixer 44 which also receives an input from the fixed offset oscillator 43. The resultant signal is mixed in another mixer 42 with the digitized and/or amplitude modulated audio signal the result of which is amplified by amplifier 46 and transmitted in the horizontal polarization mode by antenna element 16 as signal Tr 68.

40 Ghosting due to multipath propagation is eliminated because of the high selectivity narrow beamwidth of the receiver antenna 12 which is preferably placed facing the direction of the strongest transmitting antenna 62 in the array. The beamwidth of the preferred embodiment of the receiver antenna 12 is approximately 1 to 2 degrees which is sufficiently narrow when combined with a system of alternately horizontal and vertically polarized transmitting antennas T_H and T_V as shown in Figure 3 to substantially eliminate distortion. Lower gain and/or wider beamwidth antennas may be used for receivers which are located nearby the transmitting antennas. Since all desired signals should be appearing at the antenna 12 at the same level, the intermodulation level of the system 200 is controlled by adjusting the signal to noise level of the system to a predetermined value. For input signals of -40 dBm (32 dB greater than that required for excellent video quality in an FM system) and a local oscillator level of approximately +10 dBm, the expected fourth order in-band intermodulation levels would be approximately -110 dBm which is below the noise level for a typical receiver with a -72 dBm minimum acceptable signal level for excellent quality video. Cellular power levels can be maintained throughout various levels of rainfall by a receiver re-transmitter at fringe areas which feeds information back to the omni-directional transmitters 60 to change their output power or by automatic adjustment of the variable attenuator 13 for receivers not in fringe areas.

45 A block diagram schematic of the preferred embodiment of the transmitter 60 is illustrated in figure 2. Transmitter 60 is at the omni-directional radiating node of a group of cells 214H and 214V in geographical array

200 illustrated in Figure 3. A pair of multiplexer circuits 70 and 86 are used to provide frequency and digital multiplexing of a variety of signals which are to be radiated from omni-directional antenna 62. A group of signals 72 including $L_1, V_1, V_2, \dots, V_n$ are fed into FM multiplexer 70 producing a modulation band of information in the frequency range of 200 to 2200 MHz. The output band is converted by up-converter PUC 74 to the frequency range of 27.5 to 28.5 GHz according to the present example. Simultaneously an equal spectrum of digital signals 84 comprising inputs A_1, A_2, \dots, A_n are multiplexed in digital multiplexer 86 and up-converted in PUC 88 to frequencies in the range of 28.5 GHz to 29.5 GHz. The 27.5 to 28.5 GHz signal from PUC 74 is filtered by phase filter 75 and fed as a first input to power amplifier 80. A second phase filter 91 receives the 28.5 GHz to 29.5 GHz output from PUC 88 and supplies a second input to power amplifier 80.

10 The phase filter design 75 utilizes both the amplitude and abrupt phase shift characteristic of an LC network, 77, to provide a performance characteristic which is substantially better than that achievable with the same LC network used in normal configuration. See Figure 6. The phase network 75 when used to synthesize a band reject filter characteristic results in a typical rejection performance which is 50 dB using typical resonator Q's of 100. This compares to a conventional band reject filter performance of only 16 dB using LC filter elements with the same Q of 100.

15 The input signal coming into phase filter 75 is divided by a power splitter transformer, 76, into two paths; one containing an LC network 77 and the other an amplitude adjustment 78. LC network 77 could comprise an inductor, a capacitor and a resistor in series. Amplitude adjustment circuit 78 could comprise a conventional variable resistor. The output of these paths is then combined (i.e., added) by a power splitter 79 similar to power splitter 76.

20 The performance characteristic of a network using 77 and 78 as described above is

$$G = \frac{Rx - r}{(r + RL)(Rx + RL)}$$

$$G = 0 \text{ for } r = Rx$$

25 The resultant is a band pass filter network achieved by adding a 180 degree phase shift to one of the paths of the filter which exhibits a band reject characteristic with a rejection point substantially greater than that of a conventional filter with similar elements due to the vectorial cancellation.

Typical performance compared to conventional network using $L = 520.5 \text{ nH}$, $C = 2.12 \text{ pF}$ is given in Figure 6. Phase filter networks 91 and 107 work in the same manner as phase filter 75 just described.

30 The resulting 2 GHz (29.5 - 27.5 GHz) of information bandwidth is amplified by linear power amplifier 80 and then radiated to a large number of system subscribers 10 within the geographic cell 214H or 214V near omni-directional antenna 62 or via a small number of quadrant directional antennas. Omni-directional antenna 62 produces a vertically polarized transmitted signal $T_x 64$ which is received by the vertically oriented element 14 of each of the directionally oriented receiver antennas 12. The specific subdivision of 2 GHz of available bandwidth given in this example may vary with particular cells 214H and 214V within the system array 300, according to the need for and mixture of video and digital transmission requirements.

35 Up converters PUC 74 and 88 are balanced so that the frequency of master oscillator 61, for purposes of this example operating at 27,300 MHz is suppressed. A lower side band of frequencies is redundant to the transmission and are eliminated by the two differential phase shift filters 75 and 91. If more lower side band reduction is required to minimize interchannel interference, then a double balanced mixer will be used.

Up 40 The foregoing technique permits a wide variety of signal formats to be efficiently combined into a single millimeter wave carrier. This form of multiplexing allows, for example, for the use of low frequency oscillators with moderate stability (for example one part in ten to the fourth power at 100 MHz) to be translated into a variation at 28,000 MHz of 3.7 parts in 10 million assuming the oscillator locking scheme previously described. The 45 omni-directional broadcast transmitter 60 functions as the master node of each cell 214H or 214V and simultaneously acts as a receiving site for signals radiated back from individual subscriber receivers 10. The return signals $T_R 68$ may represent a variety of communication services including, but not limited to, telephone digital data communications and video conferencing. Because of the large absolute signal bandwidths available in the millimeter frequency range, for example, up to 500 MHz of signal bandwidth might be allocated to this 50 return path according to the specific needs of a particular local community. A variety of signal formats as well as simultaneous telephone channels can be accommodated. The receiver channel is isolated to a large extent by the polarization diversity between vertically transmitted signal $T_x 64$ and horizontally polarized received signal $T_R 68$. Further isolation is achieved by the frequency diversity of the transmitted signal $T_x 64$ and the received signal $T_R 68$ and by the space displacement of the multiple ring locations of the transmitter and receiver antennas as shown in Figure 4A. The transmitter antenna is always located forward of the receiver antennas. Any residual transmitter energy entering the received signal port 68 through reflections that is not severely attenuated by polarization will be sharply filtered using another differential phase shift filter 107 before being amplified by low noise intermediate microwave amplifier 112 and down converted by frequency conver-

ter FC#1 114 to a wide bandwidth of signals. The dynamic range of FC#1 is increased by using a large oscillator power at 114 and or multiple mixer diodes. This additional linearity minimizes intermodulation distortion due to the reception of multiple desired signals of unequal level or the unintentional reception of transmitter leakage. The intrinsic differentiation between frequency and amplitude modulation signal further reduces the effect of distortion and retains the fidelity of the system. Since the incoming signals are from a multitude of transmitters located at various distances from the receiver 68 the use of an input variable attenuator 13 as in the receiver is not desired. The output frequencies can then be demultiplexed by demultiplexer 115 and switched to re-transmission format An. Individual carrier signals from frequency converter FC#1 114 are also amplified by amplifier 116 and forwarded to another frequency converter FC#2 118. The output from frequency converter FC#2 118 is amplified by amplifier 121 and forwarded to discriminator 122 the output of which is individual demodulated carrier frequencies. A portion of the signal from discriminator 122 is fed back through feedback path 125 of a locking signal to variable oscillator 120 thereby stabilizing the oscillator to the input frequency converter FC#2 118. Therefore the channel to be monitored is determined by the manual adjustment of 120 and feedback path 125 which provides automatic frequency control on a single channel basis. Oscillator 120 is preferably a free running mechanical or electronically controllable variable oscillator. The Multiple digital coded signals An's, are transmitted periodically with various codes in order to activate or deactivate the individual receivers 10 located within the cells 214H or 214V. Frequency converter FC#1 114 receives its second input from up converter 96 through phase filter 99. Up converter 96 receives one input from oscillator 61 and a second input from an offset oscillator 98. Another portion of the signal from oscillator 61 is filtered through phase filter 71 to up converter PUC 88. Another offset oscillator 73 provides a second input to phase filter 71.

| | <u>Element Number</u> | <u>Element Name</u> | <u>General Description</u> | <u>Vendor</u> |
|----|-----------------------|--------------------------|---|-----------------|
| 25 | 70 | Multiplexer | Multichannel FM multiplexer using modified standard models as special designs. Could be standard unit presently used by cable industry. | Standard Unit |
| 30 | 74,88, 96 | Up converter | High level up converter for 27.5 to 29.5 GHz | TRW Trontech |
| 35 | 61 | Local Oscillator | Gunn oscillator fixed at difference frequency between 75 and 70 maximum 70 input level 1mW | MA/COM |
| 40 | 75 | Filters | See Figure 2. | See Fig. 2 |
| 45 | 80 | Power Amplifier | Frequency 27.5-29.5 GHz power output 1 WATT or 60 WATTS | Higher |
| 50 | 107, 91, 71,99 | Filter | Special design | See Fig. 2 |
| 55 | 112 | Low noise HEMP Amplifier | Gain 20 dB N.F. 3 dB frequency 27.5 to 29.5 GHz | See Fig. 2 |
| | 114 | Frequency converter | Dynamic range 100 dB N.F. = 12 dB | Trontech |

An understanding of the details of the subscriber receivers 10 and the omni-directional transmitter stations 60 is important to an understanding of the system 200 illustrated in Figure 3 as a whole. The array 200 of transmitting antennas is comprised of horizontally polarized antennas T_H 204 and vertically polarized antennas T_V

206 each inside a cell 214H or 214V respectively. The various transmitting antennas T_H and T_V could have random frequency variations thereby offering additional interference reduction from receivers in adjacent cells or could be amplitude controlled depending upon terrain and or weather conditions thereby also minimizing adjacent cell interference and allowing for a backbone network in which the said cells are slaved to a master cell in the backbone network. The specific transmitter 60 illustrated in Figure 2 transmits a vertically polarized signal T_X 64 such as might be transmitted by antenna 206. Accordingly, antenna 62 illustrated in Figure 2 is essentially identical to any one of the vertically polarized antennas 206 in Figure 3. Horizontally polarized antennas 204 are preferably positioned in the regular array such that its nearest neighbor is a vertically polarized antenna 206 rather than a horizontally polarized antenna 204. Therefore, when moving in any direction through transmitting antenna array 200 one will encounter alternating antennas 204, 206, 204, 206, 204, etc. Each omni-directional transmitting antenna 204, 206 has associated with it a group of receiving antennas including horizontally polarized antennas and vertically polarized antennas. Horizontal receiving antennas are adapted to receive horizontally polarized signals from horizontal transmitting antennas 204. Likewise vertically polarized receiving antennas are adapted to receive vertically polarized signals like T_X 64 from antennas 206 which are similar to antennas 62 illustrated in Figure 2. The relatively narrow beam width of the receiver antenna directed toward the central transmitter 204 will minimize the interference from cell 214H. Each individual transmitting antenna T_H or T_V 204 or 206 forms the central node of a cell 214H or 214V which typically includes open or more subscriber stations 210 or 212.

A typical cell 214V in its simplest form is illustrated in figure 4A. An omni or quadrant directional broadcast/receiver system 60 using low gain, space diversity antennas 62 and 66 is directed towards a high gain subscriber, dual polarization receiver 10 equipped for polarization diversity transmit/receive isolation. Vertically polarized transmitter antenna 62 produces a transmission pattern 216 that is received within the reception field 220 of subscriber antenna element 14. Similarly, transmission from the subscriber station 10 emanates from antenna element 16 as a horizontally polarized signal 222 (like T_R 66) which is received within reception field 218 of transmitter receiving antenna 66. Figure 4B illustrates a cell 214 in which two subscribers 212A and 212B communicate with a single omni-directional transmitter T_V 206. In this case the transmitter T_V 206 produces a vertically polarized substantially omni-directional signal 216 which is received by receivers 212A and 212B. Subscribers 212A and 212B respond back with narrow divergence, 2 degree, horizontally polarized signals 222A and 222B respectively which are received by node transmitter T_V 206.

The reception within an individual node 214 can be improved by means of repeaters so as to cover those areas masked by various obstacles between transmitter and receiver sites. The directional coupler 22A located in certain receiver repeaters, Figure 1C, is used to couple the received intermediate block signal by use of amplifier 102, up convert it by single sideband converter 103, and amplify again by amplifier 104 at millimeter wave frequencies. This signal is retransmitted by antenna 11 at an orthogonal polarization to the received signal, in this case horizontal, to other subscribers which may be masked from the central node signal. Since the received signal Tx has a vertical polarization the retransmitted signal T_{RR} has a horizontal polarization.

| | <u>Element Number</u> | <u>Element Port</u> | <u>Specification</u> |
|----|-----------------------|-------------------------|---|
| 40 | 102 | Amplifier | Gain 75 dB typ. ALC power output = + 10 dBm 1 dB compression = + 23 dBm |
| 45 | 103 | high level converter | Lc 8 dB Pin = + 10 dBm L.O. drive = + 17 dBm |
| 50 | 104 | HEMP Amplifier | Power output + 16 dBm (1 dB compression) Gain 15 dB |

55 This is an ideal method to cover streets in a city with large buildings on either side. An extended cell system 240 is illustrated in Figures 5A and 5B. Figure 5A an omni or quadrant broadcast transmitter system 60 located on a first hill 232 produces a vertically or horizontally polarized signal from antenna 62. A typical direct subscriber receiver system 10 located in first valley 234 receives the signal through its antenna 12. So far the sys-

tem thus described is identical to the system disclosed in Figures 1 though 4B. However, an indirect subscriber 230 located in a second valley 238 behind a second hill 236 is shielded from the signals of transmitter 60 and under normal conditions would not be able to receive its signals. By placing a repeater 224 on top of second hill 236 it is possible to relay signals from transmitter 60 to the indirect subscriber 230. Signals from omni-transmitter 60 are received by repeater antennas 226 and retransmitted out of antenna 228 to antenna 12 of the indirect subscriber 230. In this manner the effective range of omni-directional transmitter 60 is substantially increased by the use of complementary polarization repeaters 224. Repeaters 224 may be independent stand alone units or may be incorporated into the receiver system 10 of the subscriber. Theoretically the range of an individual transmitter cell 214 can be extended by the use of a large number of repeaters 224 limited only by the noise reproduction at each repeater. Low power HEMP devices should enable in the multiple rebroadcast of a single central mode transmitter. Figure 5B illustrates in a schematic top plan view how an omni-directional transmitter 60 can be located at the center of a mixed cell node including direct subscribers 10, indirect subscribers 230 and subscriber repeaters 224. The ability to extend a mixed system 240 depends significantly upon the terrain and population characteristics of the environment. For example, in a major urban area it would probably be desirable to have a closely packed array having omni-directional low power transmitter 60 alternating between vertically and horizontally polarized signals regularly spaced throughout the system. Alternatively, in more rural areas it is probably desirable to expand the area of an individual mixed cell node thereby spreading out the size of the overall system 24. Repeaters 224, utilizing high gain antennas, are preferably of the low gain variety which provide ducting of the omni-directional radiated signal along paths to receiver sites 230 which do not lie on a straight line with the omni-directional antenna 62 of the transmitter system 60. In the process of providing the signal repeat function, the repeater transmitter antennas 226 and 228 will preferably alter the polarization of the output signal to prevent multi-path fading as might occur when the repeat signal mixes with a direct signal from the omni antenna site 60.

Because of the inherently broad bandwidth capability of the multifunction cellular system 200, it may be desirable to distribute and routinely upgrade a unique set of customer authorization codes by which user sites can be authorized to receive any desired set or subset of programming and two way transmission system services. For example, once per day or even once per hour a new set of codes could be radiated to all individual users enabling those who subscribe to qualify them to receive special broadcasts or to participate in special system services such as video conferencing and so forth. Effective two way capability is not readily provided in prior art cable systems because of the need for numerous two way cable system amplifiers. However, this function can be achieved with the present invention economically in millimeter wave cellular system 200 because each site 10, 224 and 230 can have its own low power transmitter in the range of approximately 50 to 100 milliwatts. That power combined with the high gain of the receiver site antenna, typically in the range of 30 to 40 db, and narrow noise bandwidth gives them an effective radiated power (ERP) commensurate with that of the omni-directional transmission site 60. Thus two way high quality transmission and reception of signals between the master site 60 and the user sites 10, 224 and 230 is possible on a simultaneous basis.

A variety of other uses of the capabilities of the system 200 can be envisioned. For example, while receiving any selected television channel a user 10 could simultaneously be transmitting digital data back to the central site 60 containing orders for purchase that the subscriber may wish to make from stores and other vendors who subscribe to the system 200. Alternatively and simultaneously the subscriber might be transmitting digital data to the subscriber's bank or broker with specific banking and stock purchase orders. The relatively narrow beam width of the receiver antenna 210 directed toward the central transmitter 204 will minimize the interference from cell 214H. Finally, the subscriber might be communicating via telephone, carried by the system 200 rather than twisted pair telegraph wires, to the central node 60 which in turn could be patched to the public telephone network. Again, because of the frequency, polarization and space diversity aspects of the system 200, full two way communicative capabilities exist in a simultaneous fashion between any and all users 10, 224 and 230 and each central node 60 of the cellular site 200.

In summary, the system 200 is a means for providing communities, subdivided into about 10 mile (16km) diameter cells 214, a variety of two way communication services including television, both for public and private programming, digital two way transmission, special video teleconferencing, radio programming, and telephone services. This variety of simultaneous communication services is possible because of the broad bandwidth available in the 27.5 to 29.5 GHz millimeter wave bands, the unique method of providing very high Q filtering, ghosting reduction and the ability to transmit and receive numerous simultaneous signals with little or no intermodulation distortion or interaction with a moderate cost receiver.

The characteristics of the present system 200 have overcome prior art difficulties through a unique combination of separate techniques.

Polarization diversity is employed within individual cells to provide a measure of isolation between the omni-directional broadcast signals from stations 60 and the signals which return from the user sites 10, 224

or 230. For example, polarization might be used for omni-directional transmission and horizontal polarization used for signals returning from individual receiver sites 10, 224 or 230 to the omni-directional broadcast site mode 60. Adjacent geographic cells then use the reverse order of polarizations, in this case horizontal polarizations for transmission from the omni-directional transmission site 60 and vertical polarization for the signals returning from individual subscriber receivers 10, 224 and 230 to the omni site 60. In this manner polarization diversity has been used to provide maximum isolation between transmitted and received signals within a given cell 214 as well as to isolate adjacent transmission sites 60 from each other. Moreover, rebroadcast low gain repeater amplifiers 224 with reverse polarization can be strategically placed throughout the system 200 to redirect and strengthen signals to those areas 238 with less than normal minimum signal levels. Accordingly, there is not only polarization between adjacent transmitters 60, but also between the transmitters and subsequent repeaters 224 within the same individual cell 214.

Modulation diversity provides a level of decoupling between omni transmitted signals and the signals received at the omni site. Thus, for example, frequency modulation might be used for transmission from the omni site 60 while amplitude modulation or digital transmission can be used for signals returning to the master node 60 of the system 200.

Frequency diversity can be used both to separate different signals being simultaneously broadcast from the omni-directional site 60 as well as to separate signals returning from individual users 10, 224 and 230 as, for example, telephone channels, back to the master node 60.

Space diversity provides an added measure of isolation between the omni-directional radiating antenna 62 and the receiving antenna 66 located at the omni-directional site 60. As shown in Figure 4A this can be accomplished by locating the transmitting antenna 62 physically in front of the low power receiving antenna 66 at the master node 60. The fact that the receiver antenna 12 has approximately 2 degrees of reception width further spatially isolates individual subscribers 10, 224 and 230 from neighboring antenna systems. Moreover, the narrow band of the receiving antenna 12 further enhances the separation effectiveness of the transmitter node antennas 62 and 66. In other words the dual ring design allows for maximum isolation. The intrinsic isolation of the transmitting antenna 62, in addition to the polarization diversity also employed, helps to prevent transmitter signals and noise from being received in the return channel of the receiver antenna 66 at the transmitter site 60. Additional interference reduction capabilities are provided by the input level control at each receiver.

The entire system 200 employs a self-synchronizing frequency reference, thereby obviating the need for an expensive crystal controlled master oscillator at either the omni-directional 60 or receiver sites 10, 224 and 230. The self-synchronizing method employs the use of a low frequency tone modulation at the omni-directional high power transmitter site 60 designated as L_1 in the input 72 of FM multiplexer 70. All receiver sites 10, 224 and 230 include a local oscillator 26 which is tuned through the use of the reference tone L_1 to remain in synchronism with the master oscillator of the omni-directional transmitter system 60 as part of a phase lock loop system. Accordingly, all transmit and receive frequencies are synchronized within a covered cell 214. The random frequency variation of the master oscillator frequency 61 in each cell 214 coupled with the high directivity of the receiver antenna 12 provides the final degree of high isolation required for satisfactory system performance.

Lastly, the use of differential phase shift filters 75, 91 and 107 is employed throughout the system 200 to provide very high frequency isolation at low cost. This technique allows for the precise signal filtering necessary to take fullest advantage of the multi-channel capabilities of the communication system 200. These filters could have rejection capabilities as deep as 60 dB (typically 40 dB). Whereas normal band rejection filter would yield only 15 dB ($Q=100$).

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Claims

- 50 1. A point-to-multipoint television transmission system including at least one low-power transmitter station (204, 206) and a plurality of receiver stations (212), the transmitter station comprising a substantially omnidirectional transmitting antenna and each receiver station comprising a receiving antenna for receiving a television signal from said omnidirectional transmitter antenna, characterised in that the system comprises a plurality of low-power transmitter stations which transmit, at least in part, the same television signals in the millimetre waveband, in that each transmitter station is located in an area that forms a single cell (214) of a cellular system in which each cell is adjacent to at least one other cell of the cellular system and in that the receiving antenna of each receiving station is directional and directed to receive said television signals from only one of said omnidirectional transmitting antennas.

2. A system as claimed in claim 1 wherein said substantially omnidirectional transmitting antennas of said transmitter stations are located in an array such that the polarity (TV, TH) of transmitted signals at a given frequency of transmitting antennas of adjacent said transmitter stations is different.
- 5 3. A system as claimed in claim 1 or claim 2 wherein each cell partly overlaps at least one other cell.
4. A system as claimed in claim 1 wherein all the transmitter stations transmit at the same frequency.
- 5 5. A system as claimed in any one of claims 1 to 4 wherein each of said transmitted signals is at a frequency of at least 27.5 gigahertz.
- 10 6. A system as claimed in claim 5 wherein each of said transmitted signals is at a frequency in the range of 27.5 to 29.5 gigahertz.
- 15 7. A system as claimed in any one of claims 1 to 6 wherein a said transmitter station includes a transmitting antenna (62) for transmitting signals with a first given polarity (V) and a receiving antenna (66) for receiving signals of a second given polarity (H) different from said first given polarity.
- 20 8. A system as claimed in claim 7 wherein a said subscriber receiving station includes a receiving antenna polarised to receive the signals from said transmitting antenna of said transmitter station, said subscriber receiver station also including a transmitter antenna polarised to transmit signals back to the receiving antenna of said transmitter station.
- 25 9. A system as claimed in any one of claims 1 to 6 further comprising:
 - subscriber transmitter means (16) for transmitting signals from a subscriber receiver station to a transmitter station; and,
 - transmitter station receiving means (66) for receiving said signals from said subscriber transmitter means,
 - wherein said signals transmitted by said transmitter stations are different in frequency from the signals received by said transmitter stations.
- 30 10. A system as claimed in claim 9 further comprising repeater means (11, 22A, 102-104) for receiving signals and retransmitting said signals.
- 35 11. A system as claimed in claim 10 wherein the signals transmitted by said repeater means are of a different polarity from the signals received by said repeater means.
12. A system as claimed in any one of claims 7 to 11 wherein the transmitting antenna (62) and the receiving means (66) of each of the transmitter stations are physically separated.
- 40 13. A system as claimed in any one of the preceding claims wherein said directional receiving antenna has a signal pick-up angle of 2 degrees.
14. A system as claimed in any one of the preceding claims wherein said substantially omnidirectional transmitting antennas comprise quadrant broadcast antennas.
- 45 15. A system as claimed in any one of claims 1 to 14 wherein a said transmitter station includes:
 - a master oscillator (61);
 - wherein a said subscriber receiver station includes a phase lock loop (24, 26) for locking onto the frequency of said master oscillator in said transmitter station,
 - wherein the phase lock loops in said subscriber receiver station synchronizes the receiver with the frequency of said transmitter station.
- 50 16. A system as claimed in claim 15 wherein a said subscriber receiver station includes:
 - differential phase shift filter means (32) for filtering out unwanted frequencies.
- 55 17. The system of claim 16 wherein said transmitter station includes:
 - FM multiplexer (70) for multiplexing a plurality of signals;
 - a first converter (63) for converting the output from said FM multiplexer;
 - a first differential phase shift filter (75) for filtering the output from said first converter;

power amplifier means (80) having a first and second input for producing an amplified output; digital multiplexer means (86) for digitally multiplexing a second plurality of signals; a second converter (88) connected to said digital multiplexer for converting the output frequency from said digital multiplexer;

5 local oscillator means (73, 98) for providing a second input to said first converter; phase shifting means connected to said local oscillator means and to said second converter for providing a second frequency input to said second converter; a second differential phase shift filter connected to the output of said second converter, the output of said second differential phase shift filter providing the second input to said power amplifier means; 10 first antenna coupling means attached to the output of said power amplifier means, said coupling means having an output attached to the transmitting antenna (62) of said transmitter station.

18. The system of claim 17 wherein a said transmitter station further includes:

a second antenna coupling means connected to the receiving antenna (66) of said transmitter station; 15 a third differential phase shift filter (107) connected to the output of said second antenna coupling means; a first frequency converter (114) connected to the output of said third differential phase shift filter; demultiplexer means (115) connected to the output of said first frequency converter; 20 a second frequency converter (118) having an input connected to the output of said first frequency converter; feedback means (120, 125) forming a second input to said second frequency converter; discriminator means (122) connected to the output of said second frequency converter, the output of said discriminator means being coupled to the output of said cellular node transmitter station; and 25 a third converter (96) having an input connected to said local oscillator means (73, 98) and an output connected to said first frequency converter.

19. The system of claim 18 wherein a said subscriber receiver station includes:

a first frequency converter (18) connected to the receiving element of said antenna of said subscriber receiver station; 30 coupler means (22) connected to the output of said first frequency converter; first oscillator means (26) having a frequency control connection connected to said coupler means, the output of said first oscillator means connected as a second input to said first frequency converter; a second frequency converter (28) having an input connected to the output of said coupler means; 35 discriminator means (34) connected to the output of said second frequency converter; second oscillator means (38) having a control input terminal thereof connected to the output of said discriminator means, said second oscillator means further having an output terminal thereof connected as a second input to said second frequency converter; and manually tunable means (48) connected to said second oscillator means for tuning said second 40 oscillator means, wherein the output from said discriminator means forms the input to a conventional television set.

20. The system of claim 19 further comprising:

an offset mixer (44) connected to the output of said first oscillator means; 45 third oscillator means (43) connected as a second input to said offset mixer; a second mixer (42) connected to the output of said offset mixer, said second mixer having a second input connected to a source of audio digital data, wherein the output from said second mixer is connected to the transmitting antenna of said subscriber receiver station for transmitting signals back to said transmitter station with a polarity different from the signals received from said transmitter station.

Patentansprüche

- 55 1. Ein TV-Übertragungssystem von einem Punkt zu mehreren Punkten, mit mindestens einer Niederleistungsübertragungsstation (204 und 206) und einer Vielzahl an Empfangsstationen (212), wobei die Übertragungsstation über eine Haupt-Rundstrahlantenne und jeder Empfänger über eine Antenne für den Empfang der TV-Signale der Rundstrahlantenne verfügt, dadurch gekennzeichnet, daß es über eine Viel-

zahl an Niederleistungsübertragungsstationen verfügt, die zumindest dann TV-Signale im selben Millimeterwellenband übertragen, wenn sich die jeweilige Übertragungsstation in einem eine einzige Zelle (214) bildenden Bereich eines Zellensystems befindet, in dem jede Zelle zumindest an eine andere Zelle des Zellensystems angrenzt und die Empfangsantennen der jeweiligen Empfangsstationen so ausgerichtete Richtantennen sind, die nur die TV-Signale einer der Rundstrahlübertragungsantennen empfangen.

- 5 2. Ein System laut Anforderung 1, in dem die Haupt-Rundstrahlantennen der Übertragungsstationen so angeordnet sind, daß die Polarität (TV, TH) der übertragenen Signale bei einer gegebenen Frequenz unterschiedlich der der Übertragungsantennen angrenzender Übertragungsstationen ist.
- 10 3. Ein System laut den Anforderungen 1 oder 2, in dem jede Zelle zumindest teilweise in eine andere Zelle übergreift.
- 15 4. Ein System laut Anforderung 1, in dem alle Übertragungsstationen mit derselben Frequenz übertragen.
- 20 5. Ein System laut den Anforderungen 1 bis 4, in dem alle Signale mit einer Frequenz von mindestens 27,5 Gigahertz übertragen werden.
- 25 6. Ein System laut Anforderung 5, in dem alle Signale in einem Frequenzbereich zwischen 27,5 und 29,5 Gigahertz übertragen werden.
- 30 7. Ein System laut den Anforderungen 1 bis 6, in dem eine Übertragungsstation über eine Übertragungsantenne (62) zur Übertragung von Signalen mit einer ersten gegebenen Polarität (V) und über eine Empfangsantenne (66) für den Empfang von Signalen einer zweiten gegebenen, von der ersten gegebenen Polarität unterschiedlichen Polarität (H) verfügt.
- 35 8. Ein System laut Anforderung 7, in dem die Neben-Empfangsstation über eine für den Empfang der Signale der Übertragungsstation polarisierte Empfangsantenne und zugleich über eine Übertragungsantenne verfügt, die zur Rückübertragung von Signalen zur Empfangsantenne der Übertragungsstation polarisiert ist.
- 40 9. Ein System laut einer der Anforderungen 1 bis 6, das außerdem über folgendes verfügt :
 - einen Nebenstationssender (16) zur Übertragung von Signalen von einer Nebenempfangsstation zu einer Übertragungsstation, und
 - einen Sendestationsempfänger (66) zum Empfang von Signalen des Nebenstationssenders,
 wobei die von den Sendestationen übertragenen Signale eine andere Frequenz als die der Signale aufweisen, die von den Sendestationen empfangen wurden.
- 45 10. Ein System laut Anforderung 9, das außerdem über eine Umleitantenne (11, 22A, 102-104) zum Empfang und der Weiterleitung der Signale verfügt.
- 50 11. Ein System laut Anforderung 10, bei dem die von der Umleitantenne übertragenen Signale eine andere Polarität als die von der Umleitantenne empfangenen Signale aufweisen.
- 55 12. Ein System laut einer der Anforderungen 7 bis 11, bei dem die Übertragungsantenne (62) und der Empfänger (66) bei allen Übertragungsstationen physisch voneinander getrennt sind.
- 13. Ein System laut einer der vorgenannten Anforderung, bei dem die Empfangsrichtantenne einen Signal-empfangswinkel von 2 Grad aufweist.
- 14. Ein System laut einer der vorgenannten Anforderungen, bei dem die Haupt-Rundstrahlübertragungsantennen mit Quadrant-Sendeantennen versehen sind.
- 15. Ein System laut einer der Anforderungen 1 bis 14, dessen Übertragungsstation folgendes enthält :
 - einen Hauptoszillator (61),
 - eine Nebenempfangsstation verfügt dabei über eine Phasensperrschaltung (24, 26) zur Blockierung auf der Frequenz des Hauptoszillators der Übertragungsstation,
 - indem die Phasensperrschaltungen der Nebenempfangsstation den Empfänger mit der Frequenz der Übertragungsstation synchronisieren.

- 16.** Ein System laut Anforderung 15, dessen Nebenempfangsstation folgendes enthält :
einen differentiellen Phasenverschiebungsfilter (32) zur Filterung unerwünschter Frequenzen.
- 17.** Die Übertragungsstation des Systems laut Anforderung 16 enthält :
5 einen FM-Multiplexer (70) zur Bündelung einer Vielzahl an Signalen,
einen ersten Frequenzwandler (63) zur Umwandlung der Ausgangsfrequenz des FM-Multiplexers,
einen ersten differentiellen Phasenverschiebungsfilter (75) zum Filtern des Ausgangssignals des
ersten Frequenzwandlers,
einen Leistungsverstärker (80) mit einem ersten und einem zweiten Eingang zur Erzeugung eines
10 verstärkten Ausgangssignals,
einen digitalen Multiplexer (86) zur digitalen Bündelung einer Vielzahl von Signalen,
einen zweiten, an den digitalen Multiplexer angeschlossenen Frequenzwandler (88) zur Umwand-
lung der Ausgangsfrequenz des digitalen Multiplexers,
einen lokalen Oszillator (73, 98), um den ersten Frequenzwandler mit einem zweiten Eingang zu
15 versehen,
eine an den lokalen Oszillator und den zweiten Frequenzwandler angeschlossene Phasenver-
schiebung, um den zweiten Frequenzwandler mit einem zweiten Frequenzeingang zu versehen,
einen an den Ausgang des zweiten Frequenzwandlers angeschlossenen zweiten differentiellen
Phasenverschiebungsfilter, der Ausgang des zweiten differentiellen Phasenverschiebungsfilters versorgt
20 den zweiten Eingang des Leistungsverstärkers,
eine mit dem Ausgang des Leistungsverstärkers verbundene erste Antennenkopplung, die Kopp-
lung hat einen mit der Übertragungsantenne (62) der Übertragungsstation verbundenen Ausgang.
- 18.** Das System laut Anforderung 17, dessen Übertragungsstation außerdem enthält :
25 eine zweite, an die Empfangsantenne (66) der Übertragungsstation angeschlossene Antennen-
kopplung,
einen dritten, an den Ausgang der zweiten Antennenkopplung angeschlossenen differentiellen
Phasenverschiebungsfilter (107),
einen ersten, an den Ausgang des dritten differentiellen Phasenverschiebungsfilters
30 angeschlossenen Frequenzwandler (114),
einen an den Ausgang des ersten Frequenzwandlers angeschlossenen Demultiplexer (115),
einen zweiten Frequenzwandler (118) mit einem an den Ausgang des ersten Frequenzwandlers
angeschlossenen Eingang,
eine Rückkopplung (120, 125) zum zweiten Eingang des zweiten Frequenzwandlers,
35 einen an den Ausgang des zweiten Frequenzwandlers angeschlossenen Modulationswandler
(122), der Ausgang des Modulationswandlers wird mit dem Ausgang der zentralen Zellen-Übertragungs-
station gekoppelt, und
einen dritten Frequenzwandler (96), mit einem an den lokalen Oszillator (73, 98) und einem an den
ersten Frequenzwandler angeschlossenen Ausgang.
- 40** **19.** Das System laut Anforderung 18, dessen Nebenempfangsstation folgendes enthält :
einen ersten, an das Empfangsteil der Antenne der Nebenempfangsstation angeschlossenen Fre-
quenzwandler (18),
eine an den Ausgang des ersten Frequenzwandlers angeschlossene Kopplung (22),
45 einen ersten Oszillator (26) mit einem an die Kopplung angeschlossenen Frequenzregleranschluß,
wobei der Ausgang des ersten Oszillators an den zweiten Eingang des Frequenzwandlers angeschlossen
ist,
einen zweiten Frequenzwandler (28) mit einem an den Ausgang der Kopplung angeschlossenen
Eingang,
50 einen an den Ausgang des zweiten Frequenzwandlers angeschlossenen Modulationswandler (34),
einen zweiten Oszillator (38) mit einer an den Ausgang des Modulationswandlers angeschlossenen
Reglereingang, der zweite Oszillator verfügt dazu über einen Ausgang zu einem zweiten Eingang am Fre-
quenzwandler, und
eine an den zweiten Oszillator angeschlossene manuelle Frequenzabstimmung (48) zur Abstim-
mung des zweiten Oszillators, wobei der Ausgang des Modulationswandlers den Anschluß an ein norma-
55 len TV-Geräts bildet.
- 20.** Das System laut Anforderung 19 enthält zusätzlich :

5 einen an den Ausgang des Oszillators angeschlossenen Versetzungsmischer (44),
 einen dritten, als zweiten Eingang an den Versetzungsmischer angeschlossenen Oszillator (43),
 einen zweiten, an den Ausgang des Versetzungsmischers angeschlossenen Mischer (42), der
 zweite Mischer hat einen zweiten, an die Quelle digitaler Audiodaten angeschlossenen Eingang,
 wobei der Ausgang des zweiten Mixers für die Rückübertragung der von der Übertragungssta-
 tion erhaltenen Signale mit einer anderen Polarität als mit der, mit der die Signale von der Übertragungs-
 station erhalten wurden, an die Übertragungsantenne der Nebenempfangsstation angeschlossen ist.

10 **Revendications**

1. Système de transmission de télévision d'un point vers plusieurs points comprenant au moins un poste émetteur de basse puissance (204, 206) et une pluralité de stations réceptrices (212), le poste émetteur comprenant une antenne émettrice pratiquement omnidirectionnelle et chaque station réceptrice comprenant une antenne réceptrice pour la réception d'un signal de télévision en provenance de ladite antenne émettrice omnidirectionnelle, caractérisé en ce que le système comprend une pluralité de postes émetteurs de basse puissance qui émettent, au moins en partie, les mêmes signaux de télévision dans la bande millimétrique, en ce que chaque poste émetteur est situé dans une zone formant une cellule unique (214) d'un système cellulaire dans lequel chaque cellule est adjacente à au moins une autre cellule du système cellulaire et en ce que l'antenne réceptrice de chaque station réceptrice est directionnelle et orientée de façon à recevoir lesdits signaux de télévision de seulement une desdites antennes omnidirectionnelles.
2. Système suivant la revendication 1, dans lequel lesdites antennes émettrices pratiquement omnidirectionnelles desdits postes émetteurs sont situées suivant une matrice telle que la polarité (TV, TH) des signaux transmis à une fréquence donnée par les antennes émettrices de postes adjacents desdits postes émetteurs est différente.
3. Système suivant la revendication 1 ou la revendication 2, dans lequel chaque cellule recouvre partiellement au moins une autre cellule.
4. Système suivant la revendication 1, dans lequel tous les postes émetteurs émettent à la même fréquence.
5. Système suivant l'une quelconque des revendications 1 à 4, dans lequel chacun desdits signaux transmis est à une fréquence d'au moins 27,5 gigahertz.
6. Système suivant la revendication 5, dans lequel chacun desdits signaux transmis est à une fréquence située dans la plage de 27,5 à 29,5 gigahertz.
7. Système suivant l'une quelconque des revendications 1 à 6, dans lequel un desdits postes émetteurs comprend une antenne émettrice (62) pour l'émission de signaux ayant une première polarité donnée (V) et une antenne réceptrice (66) pour la réception de signaux d'une seconde polarité donnée (H) différente de ladite première polarité donnée.
8. Système suivant la revendication 7, dans lequel une desdites stations réceptrices d'abonné comprend une antenne réceptrice polarisée pour la réception des signaux de ladite antenne émettrice dudit poste émetteur, ladite station réceptrice d'abonné comprenant également une antenne émettrice polarisée pour l'émission de signaux en retour vers l'antenne réceptrice dudit poste émetteur.
9. Système suivant l'une quelconque des revendications 1 à 6, comprenant en plus :
 - un moyen d'émission d'abonné (16) pour l'émission des signaux à partir d'une station réceptrice d'abonné vers un poste émetteur, et
 - un moyen de réception de poste émetteur (66) pour la réception desdits signaux dudit moyen d'émission d'abonné,
 - dans lequel lesdits signaux émis par lesdits postes émetteurs sont d'une fréquence différente de celle des signaux reçus par lesdits postes émetteurs.
- 55 10. Système suivant la revendication 9, comprenant en plus un répéteur (11, 22A, 102-104) pour la réception de signaux et la retransmission desdits signaux.

11. Système suivant la revendication 10, dans lequel les signaux émis par ledit répétiteur sont d'une polarité différente de celle des signaux reçus par ledit répétiteur.
12. Système suivant l'une quelconque des revendications 7 à 11, dans lequel l'antenne émettrice (62) et le moyen de réception (66) de chacun des postes émetteurs sont séparés physiquement.
13. Système suivant l'une quelconque des revendications précédentes, dans lequel ladite antenne réceptrice directionnelle possède un angle de captation de signaux de 2 degrés.
14. Système suivant l'une quelconque des revendications précédentes, dans lequel ladite antenne émettrice pratiquement omnidirectionnelle comprend des antennes de radiodiffusion de secteur.
15. Système suivant l'une quelconque des revendications 1 à 14, dans lequel un dit poste émetteur comprend :
- un maître oscillateur (61),
 - dans lequel une dite station réceptrice d'abonné comprend une boucle de blocage de phase (24, 26) pour blocage sur la fréquence dudit maître oscillateur dans ledit poste émetteur,
 - dans lequel lesdites boucles de blocage de phase dans ladite station réceptrice d'abonné synchronisent le récepteur sur la fréquence dudit poste émetteur.
16. Système suivant la revendication 15, dans lequel une dite station réceptrice d'abonné comprend :
- un filtre de déphasage différentiel (32) pour l'élimination par filtrage des fréquences indésirables.
17. Système suivant la revendication 16, dans lequel ledit poste émetteur comprend :
- un multiplexeur FM (70) pour le multiplexage d'une pluralité de signaux,
 - un premier convertisseur (63) pour la conversion de la sortie dudit multiplexeur FM,
 - un premier filtre de déphasage différentiel (75) pour le filtrage de la sortie dudit premier convertisseur,
 - un amplificateur de puissance (80) ayant une première et une seconde entrée pour la production d'une sortie amplifiée,
 - un multiplexeur numérique (86) pour le multiplexage numérique d'une seconde pluralité de signaux,
 - un second convertisseur (88) connecté audit multiplexeur numérique afin de convertir la fréquence de sortie dudit multiplexeur numérique,
 - un oscillateur local (73, 98) afin de fournir une seconde entrée audit premier convertisseur,
 - un dispositif de déphasage connecté audit oscillateur local et audit second convertisseur afin de fournir une seconde entrée de fréquence audit second convertisseur,
 - un second filtre de déphasage différentiel connecté à la sortie dudit second convertisseur, la sortie dudit second filtre de déphasage différentiel fournissant la seconde entrée audit amplificateur de puissance,
 - un premier moyen de couplage d'antenne raccordé à la sortie dudit amplificateur de puissance, ledit moyen de couplage ayant une sortie raccordée à l'antenne émettrice (62) dudit poste émetteur.
18. Système suivant la revendication 17, dans lequel un dit poste émetteur comprend en plus :
- un second moyen de couplage d'antenne raccordé à l'antenne réceptrice (66) dudit poste émetteur,
 - un troisième filtre de déphasage différentiel (107) raccordé à la sortie dudit second moyen de couplage d'antenne,
 - un premier convertisseur de fréquence (114) raccordé à la sortie dudit troisième filtre de déphasage différentiel,
 - un démultiplexeur (115) raccordé à la sortie dudit premier convertisseur de fréquence,
 - un second convertisseur de fréquence (118) ayant une entrée raccordée à la sortie dudit premier convertisseur de fréquence,
 - un moyen de rétroaction (120, 125) formant une seconde entrée audit second convertisseur de fréquence,
 - un discriminateur (122) raccordé à la sortie dudit second convertisseur de fréquence, la sortie dudit discriminateur étant couplée à la sortie du poste émetteur dudit noeud cellulaire, et
 - un troisième convertisseur (96) ayant une entrée connectée audit oscillateur local (73, 98) et une sortie connectée audit premier convertisseur de fréquence.
19. Système suivant la revendication 18, dans lequel une dite station réceptrice d'abonné comprend :

un premier convertisseur de fréquence (18) connecté à l'élément récepteur de ladite antenne de ladite station réceptrice d'abonné,

un moyen de couplage (22) connecté à la sortie dudit premier convertisseur de fréquence,

5 un premier oscillateur (26) ayant une connexion de commande de fréquence connectée audit moyen de couplage, la sortie dudit premier oscillateur étant connectée comme seconde entrée audit premier convertisseur de fréquence,

un second convertisseur de fréquence (28) ayant une entrée connectée à la sortie dudit moyen de couplage,

10 un discriminateur (34) connecté à la sortie dudit second convertisseur de fréquence,

un second oscillateur (38) dont une borne d'entrée de commande est connectée à sortie dudit discriminateur, ledit second oscillateur ayant en plus une borne de sortie connectée comme seconde entrée audit second convertisseur de fréquence, et

15 un moyen ajustable manuellement (48) connecté audit second oscillateur afin de régler ledit second oscillateur, dans lequel la sortie dudit discriminateur forme l'entrée d'un poste de télévision classique.

20. Système suivant la revendication 19, comprenant en plus :

un mélangeur offset (44) connecté à la sortie dudit premier oscillateur,

un troisième oscillateur (43) connecté comme seconde entrée audit mélangeur offset,

20 un second mélangeur (42) connecté à la sortie dudit mélangeur offset, ledit second mélangeur ayant une seconde entrée connectée à une source de données audio numériques,

dans lequel la sortie dudit second mélangeur est connectée à l'antenne émettrice de ladite station réceptrice d'abonné pour l'émission de signaux en retour vers ledit poste émetteur à une polarité différente de celle des signaux reçus dudit poste émetteur.

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FIG. 1A

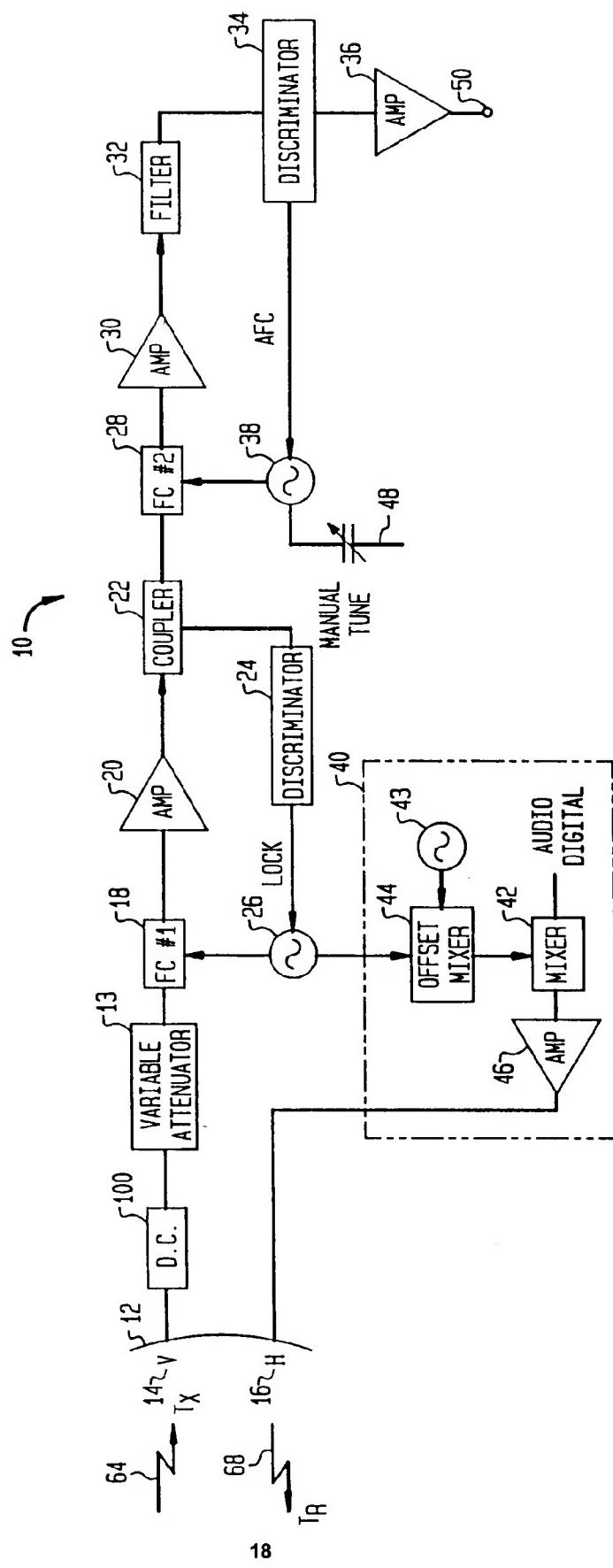


FIG. 1B

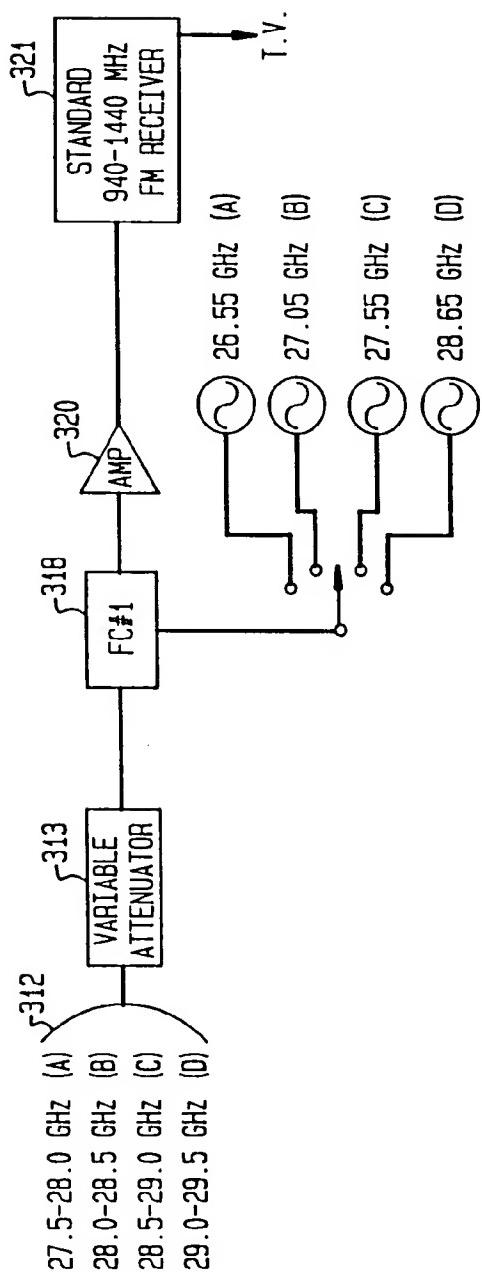


FIG. 1C

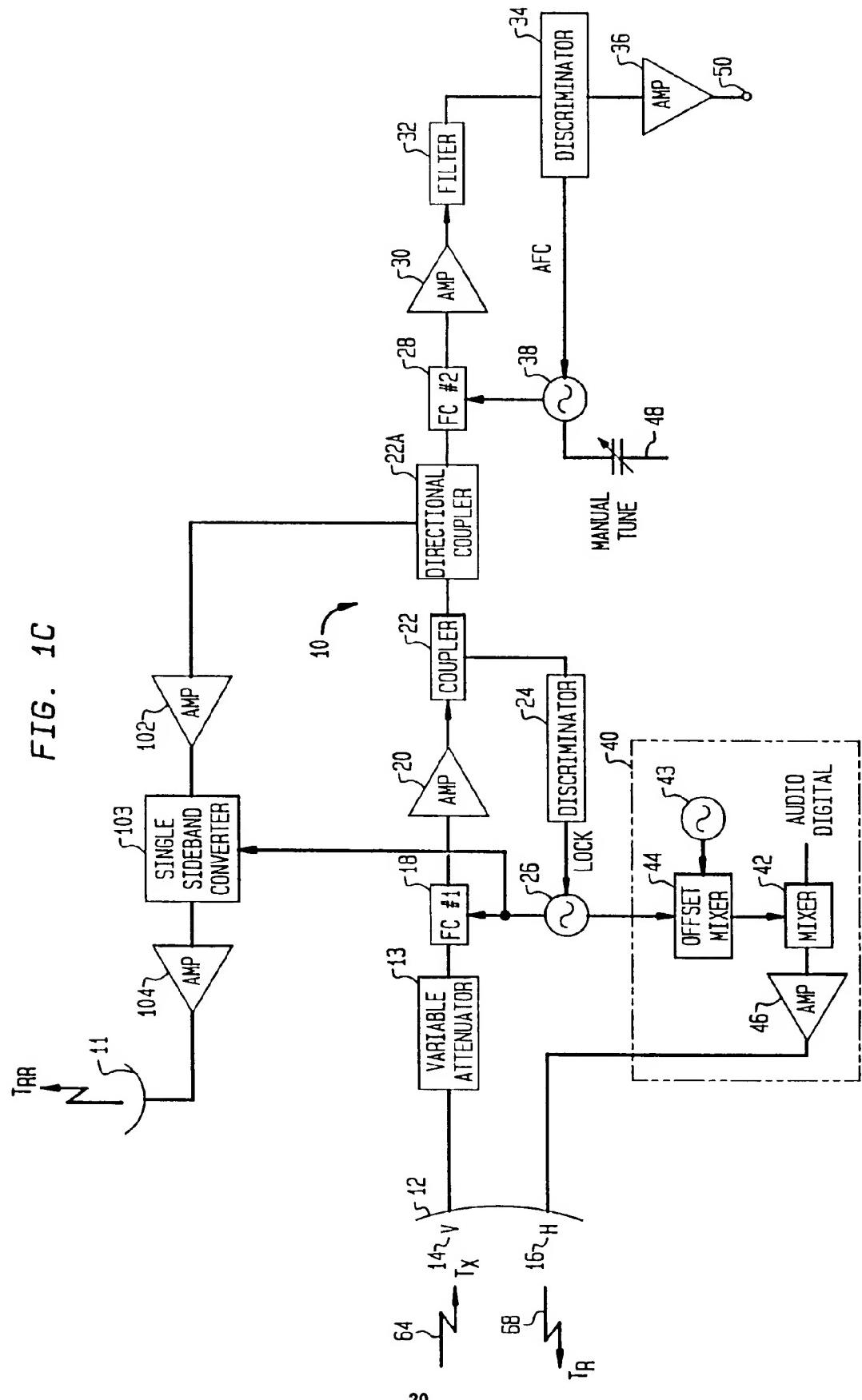


FIG. 2

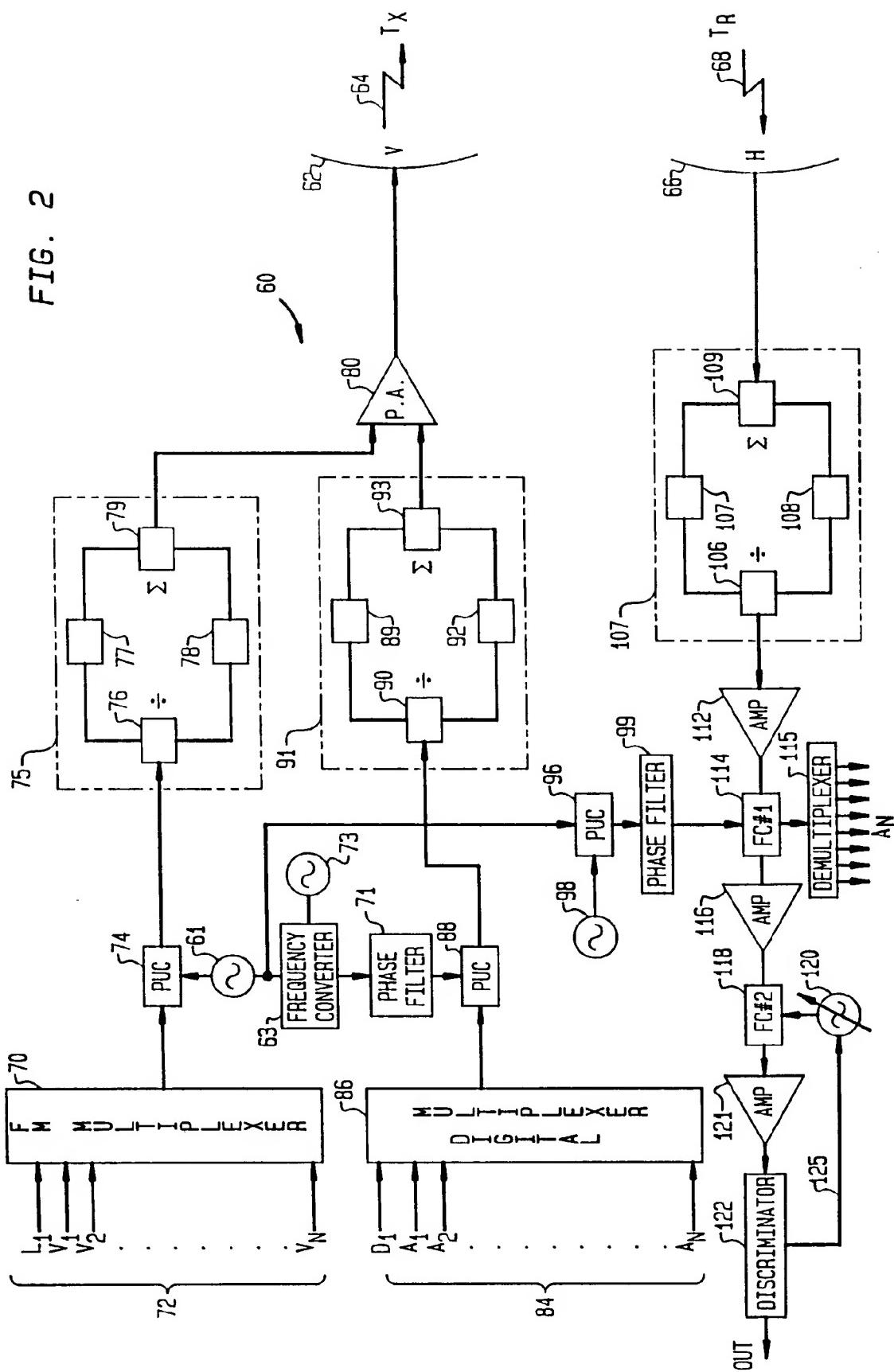
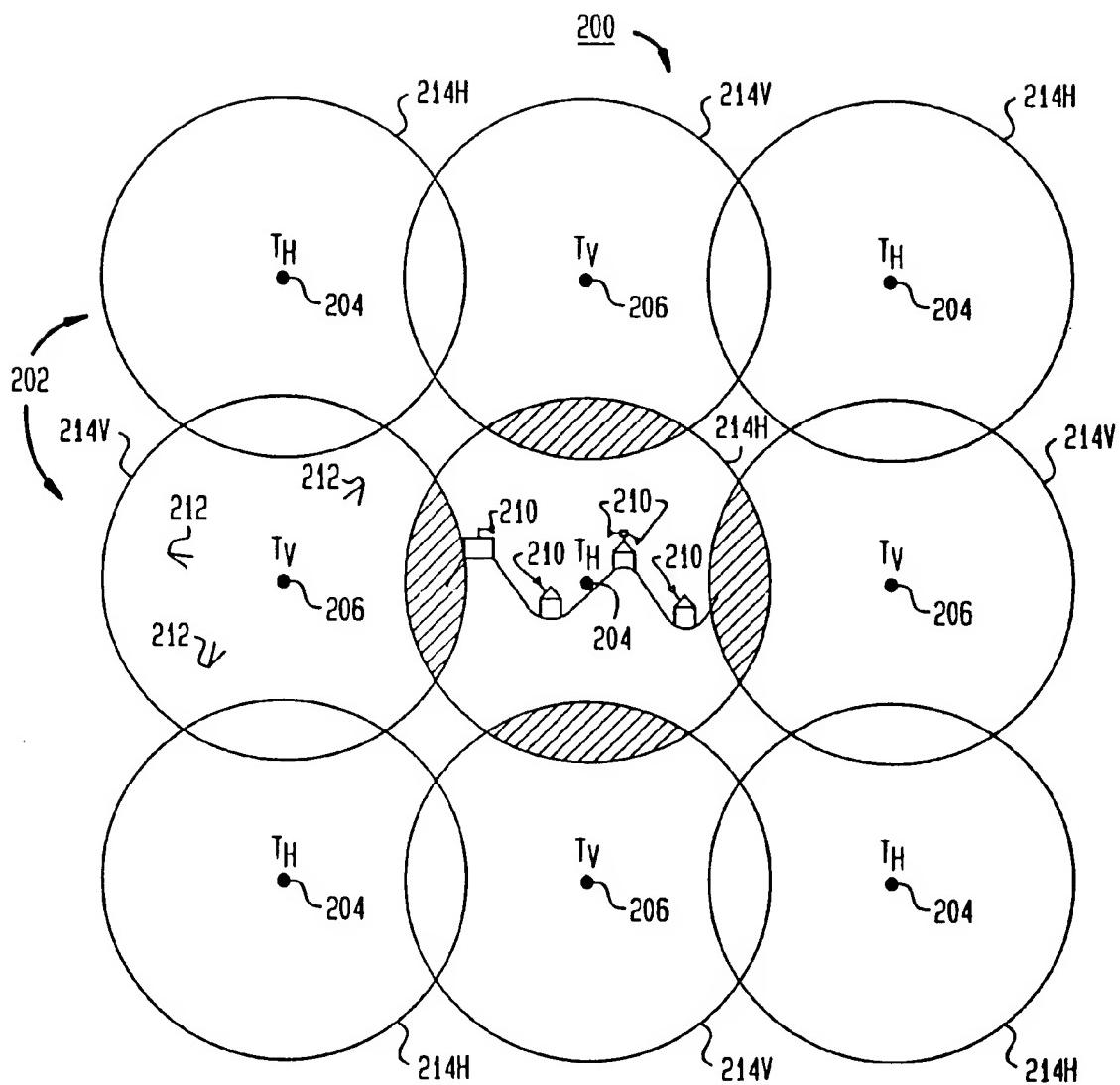
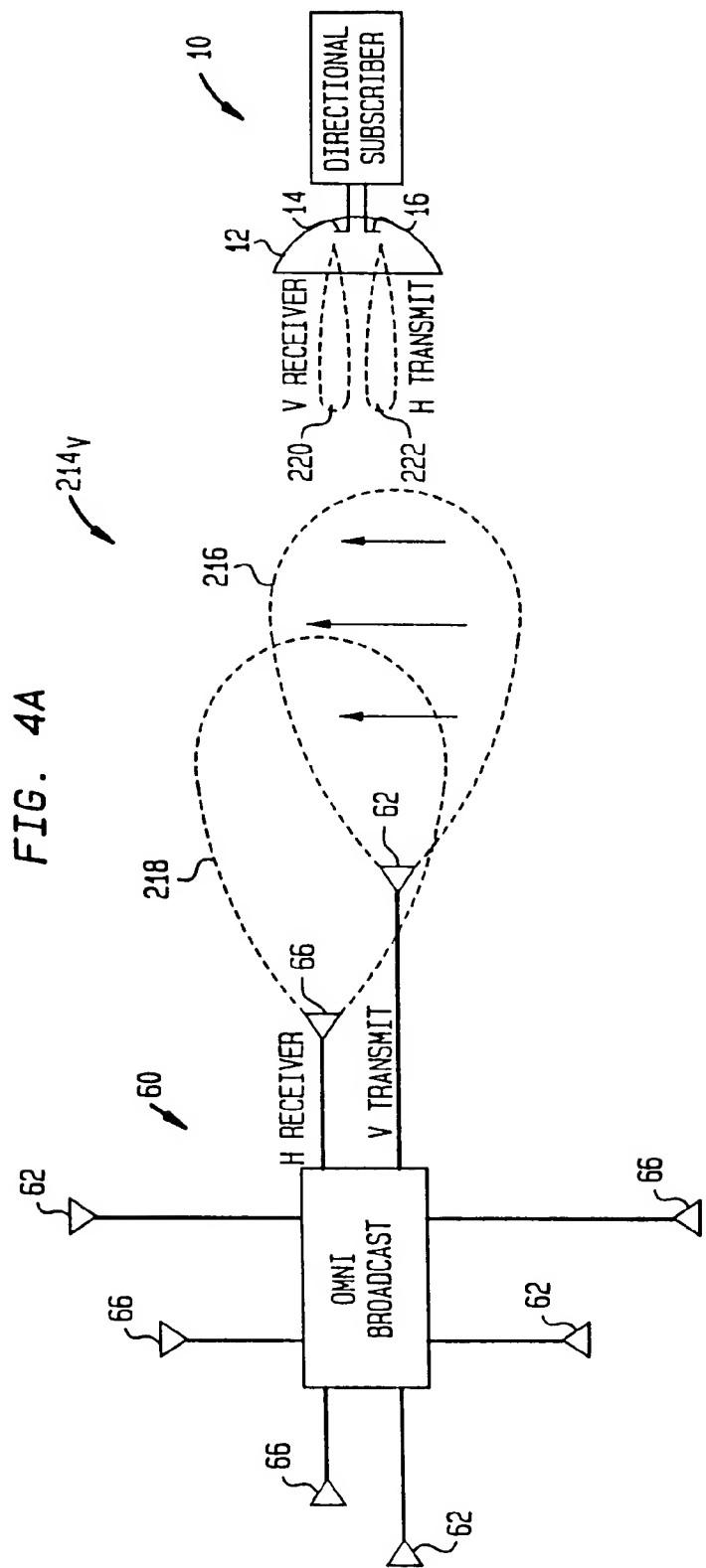


FIG. 3





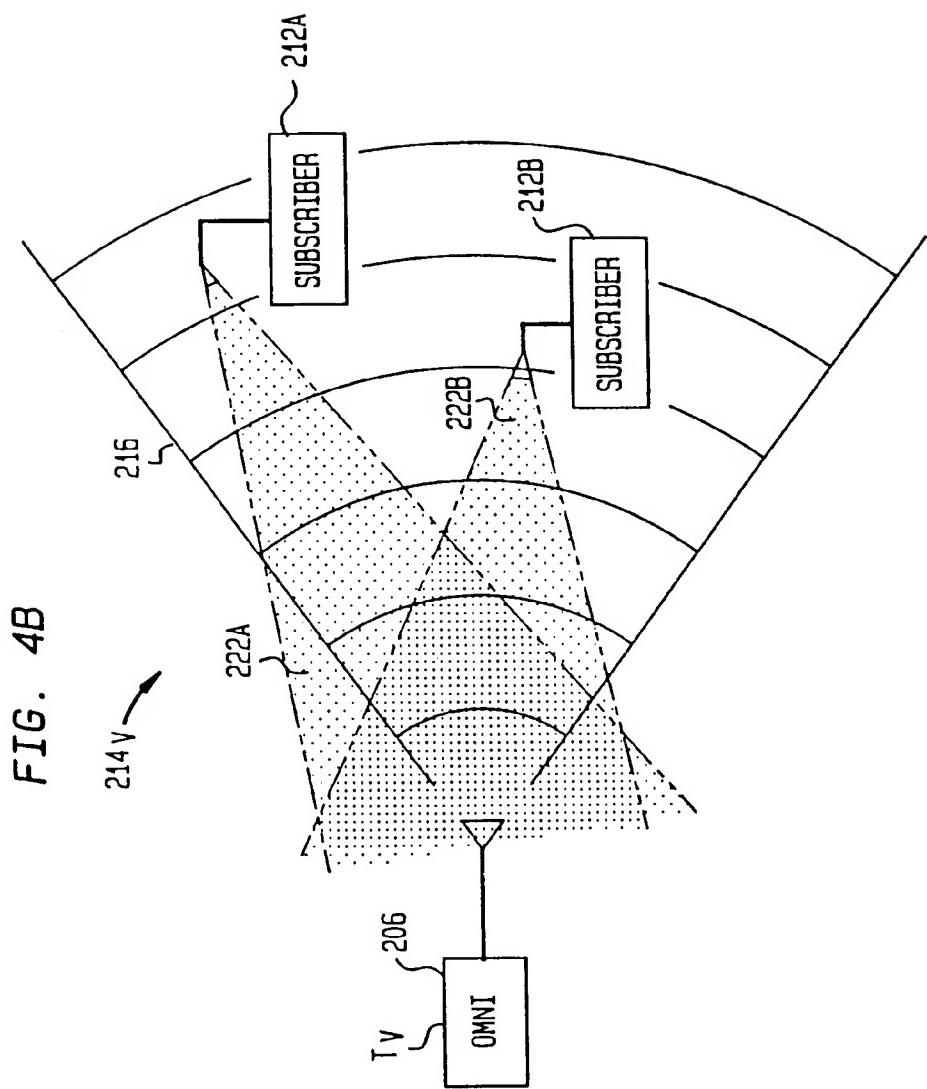


FIG. 5A

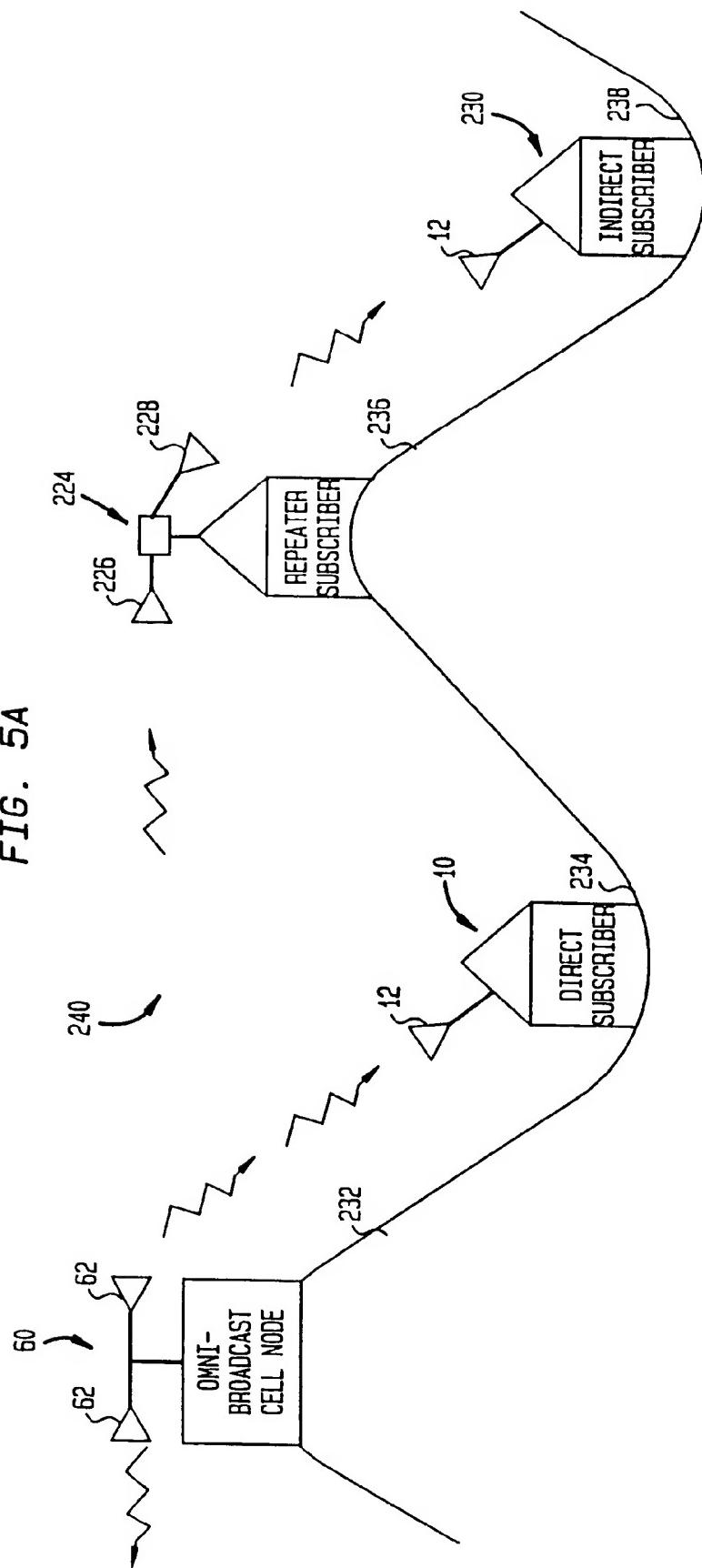


FIG. 5B

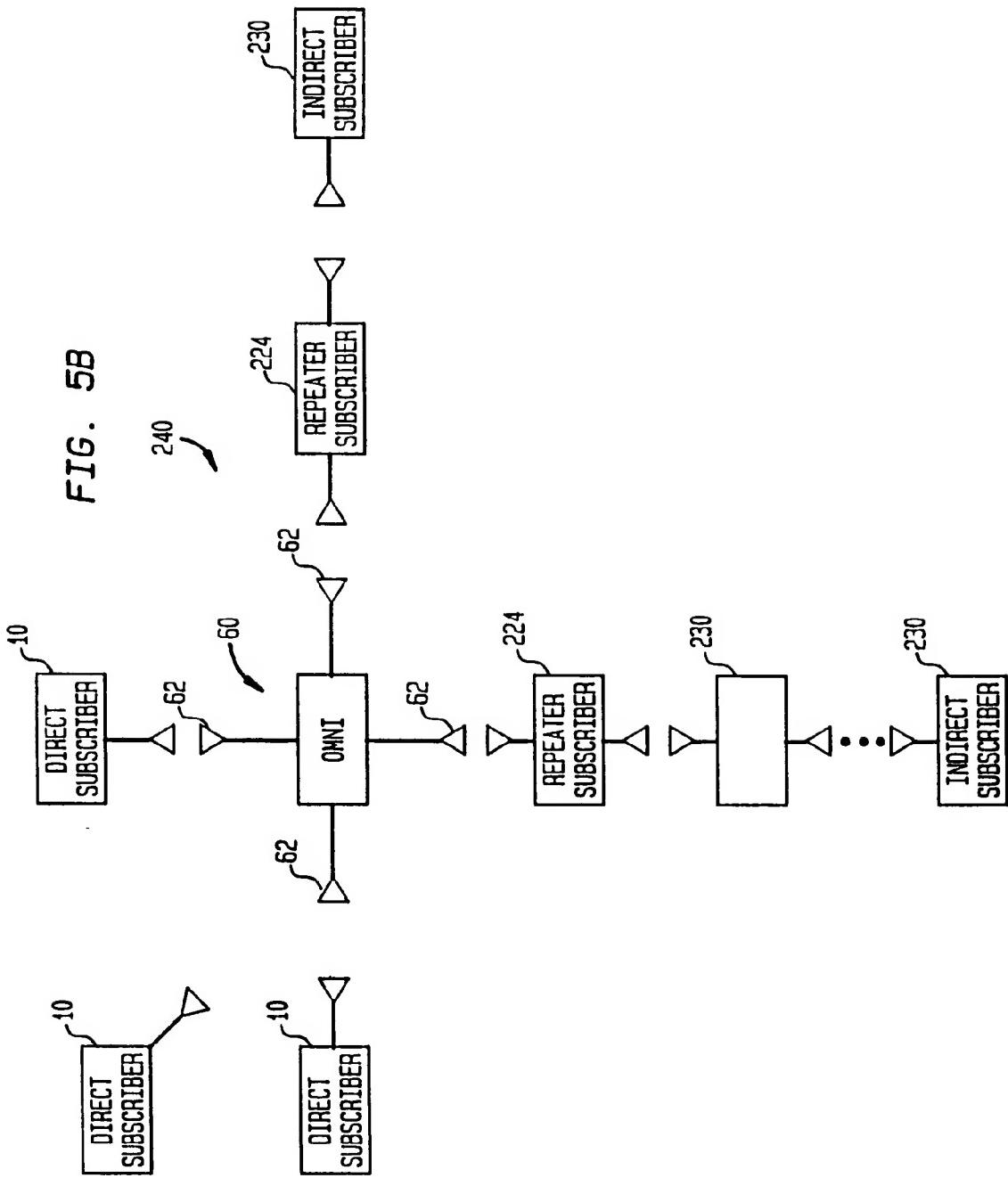


FIG. 6

